

that along a line answering to the position of the cardinal septum, the corallum is split, and the ends of these layers are turned or tucked inwards, towards the interior of the visceral chamber. In another example there is a similar incision on the ventral face, answering to the counter septum, thus separating the corallum as it were into two triangular halves. A similar division is sometimes visible in *Goniophyllum pyramidale*,* and it is also shown in Bayle's figure of *Rhizophyllum gervillei*,† on the ventral face, although in this instance the epitheca seems to be preserved. On the other hand I have failed to detect any division along the lateral angles as described by Lindström in the calice of *Goniophyllum*,‡ separating the corallum in that genus into four portions. Both in *R. australe* and *R. interpunctatum*, when epithecate, the above incisions, as previously mentioned, are replaced by a faint angulation or ridging of the surface, but this does not approach anything like the definite rib seen on Lindström's beautiful figure of *Rhizophyllum gothlandicum*.§

NOTES ON THE STRUCTURE OF *PEDIONOMUS TORQUATUS*, WITH REGARD TO ITS SYSTEMATIC POSITION.

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THE Trustees of the Australian Museum have, besides many other valuable birds forwarded through the Curator, Dr. Ramsay, to the Cambridge Museum of Zoology, sent two well preserved spirit specimens of *Pedionomus torquatus*, and Dr. Ramsay has more than once expressed the wish that I should determine the affinities of this peculiar bird. Although I have much pleasure in making the following communication, I do so with some reluctance, because of the incomplete state of my investigations. Two intact specimens of *Pedionomus* would be of course sufficient for an extensive and amply illustrated monograph, if such were desirable,

* Lindström, Bihang K. Vet. Akad. Handl. Stockholm, 1882, vii. No. 4, t. 5, f. 1.

† Expl. Carte Géol. France, 1878, iv. Atlas, t. 17, f. 13.

‡ Geol. Mag., 1866, iii. p. 358.

* Bihang K. Vet. Akad. Handl. Stockholm, 1882, vii. No. 4, t. 3, f. 4.

but in order to sift the somewhat intricate relationship of this bird, it would be necessary not only to compare it with the Rasores s. Gallinæ and with the Turnices s. Hemipodii, but also with interesting and outlying forms such as *Thinocorus*, *Attagis*, *Mesites*, and various other Limicoline and Ralline genera. *Thinocorus*, *Attagis*, and *Mesites* I have not yet been able to procure; of Turnix I have only *T. sykesi*, in spirits, although several skeletons of other species, I cannot therefore make such comparisons as I would wish,—hence the scantiness of my communication.

However it reveals something, namely that *Pedionomus* is closely allied to the Turnices, although not closely enough to include it in that group, unless the limits and the definition of the group be considerably widened. Moreover, it connects the Turnices with the Rasores, not directly, but through a number of characters which indicate the common descent of both from some less differentiated and less specialised Ralline-Limicoline stock. How the various branches of our much searched for hypothetical tree converge and diverge is another question. Suffice it to hint at the possible advisability of a Rallo-Galline combination. Fuerbringer, in his monumental work, Taf. xxix.*a* indicates such a combination as optional, but not so on pp. 1566 and 1567.

I do not know that anyone else has published a single line on the anatomy of *Pedionomus*. Garrod does not mention it at all. Fuerbringer, p. 1250 says only "the change of the Turnicidæ into proper cursorial birds has secondarily (via *Pedionomus*) caused the loss of the hallux." Forbes refers to it in his list of Tridactyle birds (Ibis 1882, p. 389) thus: "Turnicidæ, (exc. *Pedionomus*)" meaning that *Pedionomus* has four toes; in another paper (Ibis, 1882, p. 428) he enumerates it as the last of the eleven known species of Turnicidæ. That Gray (Handlist of Birds, Vol. ii., p. 271, gen. No. 2429, and Genera of Birds, Vol. iii., p. 511, pl. 131, fig. 3) referred *Pedionomus* to his Turnicinæ, speaks well either for his sagacity or for the occasional value of some of the so-called external characters, but he was wrong in letting the Turnicinæ form a subfamily of the Tetraonidæ, the latter being the fourth family of his order Gallinæ.

Tegumentary System.

The primary remiges are ten in number, of which the seventh to tenth or most distal quills form the tip of the wing; the eighth and ninth are slightly longer than the rest, but there is no trace of an eleventh quill. Each of the ten primaries possesses an upper large covert, but there is no distinct trace of an eleventh upper covert. The secondary remiges or cubitals consist of eleven longer quills and two or three much weaker and shorter quills on the elbow, a character which occurs also in the Rasores, but not in the Turnices. The fifth cubital is absent, although it is present both in the Turnices and Rasores. The alula or wing of the pollex is

composed of three quills of which the distal one is the longest, and the proximal one the shortest. The pollex shows no indication of a horny nail. The rectrices are twelve in number; they are all soft and very short; the central pair is the longest, the others shorten gradually towards the outside. The Turnices have likewise twelve rectrices, while in most of the Rasores the number is increased.

The dorsal feather tract is interrupted by a long spinal apterium which begins on a level with the shoulder-joint and is continued a little beyond the level of the hipjoint. Each half of the tract is composed of three to seven rows of feathers of which those nearest the middle line are the strongest. Behind the spinal apterium the tract is continued on to the oil-gland. The humero-scapular tract is very broad, its feathers are longer than the cubitals and form a conspicuous parapteron. This humeral tract is connected through sparingly developed feathers on to the ventral middle cervical tract, but not at all with the dorsal cervical tract, which latter occupies the whole dorsal surface of the neck. The femoral tract is isolated and very distinct; its feathers are so long that they form the chief covering of the outer surface of the fleshy part of the leg. The feather tracts on the under surface:—the under surface of the neck is covered uniformly, then the tract divides, leaving a bare interclavicular space. Each tract divides again on a level with the anterior end of the keel, into a lateral thick patch which extends over the lateral part of the sternum, over the sternal ribs, and into a narrower branch which runs nearer the middle line, where it swells out on the abdomen and then narrows again, being continued by scattered feathers towards the hinder end of the os pubis. The whole distribution and shape of the feather tracts closely resemble that of the Turnices.

The aftershaft is present, very thin and delicate, but much longer than in the Rasores. The oil-gland is large and tufted, it is otherwise naked except on the dorsal middle line on which the spinal tract is continued. The nostrils are formed by very long and wide slits; they are protected by a large, soft upper valve, which internally is composed of a cartilaginous thin plate. The whole operculum is quite bare of feathers. The sheath of the bill is composed of one piece only. The tarso-metatarsus is covered in front with one row of about twelve or more transverse scutes, which reach over to the median and outer side. The posterior or plantar surface is protected by a similar row of transverse scutes. The narrow space between the dorsal and ventral row of scutes is filled by one row of small granular scales on the outer side, by two rows on the median side. The same covering of small granular scales exists on the distal half of the bare portion of the leg. The plantar side of the whole heel is covered with numerous narrow transverse scutes; the outer and median spaces are filled up by small granular scales. The number of toes is four, the hallux

being weak but functional; all the toes are furnished with very short nails. But for the bare distal portion of the leg, and the presence of the hallux, the whole foot of *Pedionomus* closely resembles that of the Turnices and differs from that of the Rasores although its intermediate position between a *pes cursorius* and a *pes radens* is obvious.

Muscular System.

The muscles of the hindlimb afford some interesting points. Garrod's formula for the Rasores is $A B \times y +$, meaning that these birds retain the primitive condition in which besides others the following muscles are present:—

+ = M. ambiens.

A = Femoro-caudal muscle, *i.e.* pars caudalis m. caudilio-femoralis.

B = Accessory femoro-caudal, *i.e.* pars iliaca m. caudilio-femoralis.

\times = Semitendinosus *i.e.* the tibial insertion of the m. caudilio-flexorius.

y = Accessory semitendinosus, *i.e.* the femoral insertion of the m. caudilio-flexorius.

In a few of the Rasores, *viz.* in *Pavo* and *Meleagris*, and in a few other birds *e.g.* in *Podiceps*, *Otis*, *Dicholophus*, *Serpentarius*, *Phenicopterus*, &c., the caudal portion of the m. caudilio-femoralis is absent, the formula being $B \times y$. In the Turnices on the other hand the iliac portion of this muscle is absent; consequently $A \times y$. In *Pedionomus* both portions are present, but while the iliac portion is very broad and is inserted nearly along the whole length of the femur, the caudal portion is an extremely thin and feeble slip which comes as a mere thin tendon from one of the caudal vertebræ, and can scarcely be traced as an independent slip beyond the pubis, where it practically disappears and merges into the iliac portion of the muscle. The formula for *Pedionomus* is therefore $A B \times y$ as in most Rasores, and if the reduction of A were continued, *Pedionomus* would have the same symbolic formula as *Pavo*, *Meleagris*, *viz.* $B \times y$. Certainly there is no resemblance between *Pedionomus* and *Turnix* in this respect, but it would be very rash to conclude that *Pedionomus* is allied to the Rasores because of this formula. On the contrary we have to conclude that *Pedionomus* still retains partly the primitive condition, and that the reduction of the muscle A is due to the same unknown causes which have eliminated it in *Pavo* and in *Meleagris*, in *Podiceps*, *Otis*, *Dicholophus*, *Serpentarius*, and in *Phenicopterus*, *i.e.* in birds which prove that the absence or presence of this muscle can be only of very little taxonomic value.

Fuerbringer's Table XLn. B. contains several other myological characters, Nos. 30 – 42 of occasional taxonomic value, but they are not suitable for the solution of the question if *Pedionomus* is

more nearly allied to the "Galli" or to the "Hemipodii," because these two groups either agree with each other or the characters differ too much within the "Galli" themselves.

Vascular and Respiratory System.

Pedionomus possesses two carotides profundæ s. carotides subvertebrales; the left carotis is slightly weaker than the right and covers the latter ventrally. *Pedionomus* agrees in this respect with most (but not with all) Rasores, not necessarily however because of any close affinity with them, but because the presence of these two subvertebral carotids is an old, unchanged feature, which persists in most birds. In *Turnix* and in the Megapodidæ there is one carotis-conjuncta, but the right root, i.e. the basal portion of the original right carotis, has been obliterated. It is not likely that this condition has been developed directly from that of *Pedionomus*, because in this bird the basal portion of the left carotis is slightly the weaker one, on the contrary it shows that *Pedionomus* has made an independent departure. The trachea is peculiarly flattened dorso-ventrally, as in the Ratitæ. Its numerous cartilaginous rings are soft and very narrow. The Syrinx exhibits no specially remarkable features, it agrees in its composition closely with that of *Turnix* and differs from that of the Rasores. The pessulus is very weak and there is no distinctly separated branchidesmus. The semi-rings of the bronchi surround the whole ventral surface of the latter. The voice is produced (1) by a pair of membranæ tympaniformes internæ, which from the pessulus onwards occupy the whole dorsal and median half of each bronchus, (2) by several pairs of membranæ tympaniformes externæ, the first of which is the largest and lies between the first and second semi-ring of each bronchus, while smaller membranes exist between two and two of the following semi-rings. The voice is moderated by two pairs of muscles. Each m. sterno-trachealis runs down from the larynx along the side of the trachea and is inserted on to the lateral anterior process of the sternum. Each m. tracheo-bronchialis begins at the point where the m. sterno-trachealis leaves the trachea, runs along its side and is inserted upon the middle of the first bronchial semi-ring. The whole syrinx is distinctly tracheo-bronchial.

Alimentary System.

Neither *Turnix* nor *Pedionomus* possesses a crop, but the upper half of the œsophagus is very dilatable. The gizzard is very strong and of a rounded-off rhombic shape,* without the marked constriction on its upper anterior margin which exists in the gizzard of Turnices and Rasores. *Turnix* and *Pedionomus* agree however in having a slight indication of a pyloric stomach. The rest of the alimentary canal of *Pedionomus* forms three great loops. The

* Contents: quartz pebbles, and several hard Colæoptera.

first, the duodenum, descends straight down and thus turns slightly towards the right with its apex. The second loop lies on the right side, near the back, its distal third is bent upwards; the whole loop is a closed one, and is retrograde with reference to the course of the duodenum. The third principal loop takes up the space between the first and the second loops, it is likewise retrograde, but open; the middle portion of both its branches is irregularly kinked; its ascending branch is accompanied by the two well developed caeca. The intestinal convolutions of *Pedionomus* are certainly different from those of either Turnices or Rasores. There is no indication of a horseshoe-shaped doubling of the second loop, nor do the convolutions of *Pedionomus* agree in numbers and other characters with those of the groups mentioned above. The convolutions of *Pedionomus* exhibit characters which are intermediate between those of Ralli, Turnices and Rasores, and which are at the same time peculiarly modified.

Measurements: Absolute length of the intestine from the pylorus to the anus 47 cm.

Relative length of the intestine 6.5 cm.

Absolute length of the rectum 4.2 cm.

Absolute length of one cœcum 5.5 and 7.0 cm.

The liver of *Pedionomus* consists apparently of three almost equally sized lobes, owing to the left original lobe being split in half. In this respect *Pedionomus* agrees only with the Turnices and with the Rasores, it differs however from the latter and agrees with the former by the small size of the right lobe, which is scarcely half the size of the double left lobe.

Skeleton.

The number of cervical vertebræ is fifteen in *Pedionomus* and in the Turnices, sixteen in the Rasores. The last two of these vertebræ carry long dorsal ribs but without sternal portions. Although *Pedionomus* agrees with the Turnices in the number of cervical vertebræ, it differs from the Turnices (at least from *Hemipodius pugnax*, of Fuerbringer, *op. cit.* p. 240) in the composition of the brachial nerve plexus. The latter is formed in *Hemipodius* by the eleventh to fourteenth spinal nerves, in *Pedionomus* by the twelfth to fifteenth, in the Rasores by the thirteenth to sixteenth or thirteenth to seventeenth spinal nerves. In *Pedionomus* five, almost six ribs, belonging to the sixteenth to twentieth or twenty-first vertebræ are attached to the sternum; in the Turnices only three or seven, rarely five; in the Rasores almost always four, very rarely only three. The greater number of these sternal ribs is a more primitive, Ralline character. The sternum of *Pedionomus* is decidedly like that of the Turnices and differs in every essential point from that of the Rasores. The posterior margin of the sternum possesses only one notch of moderate depth on each side, only the Processus lateralis posterior but no Proc.

obliquus being developed. The spina anterior sterni, is a spina communis, being composed of a very feebly developed spina externa and a short and bifurcated spina interna, without a foramen inter-spinale for the reception of the feet of the coracoids. The median apophysis of the furcula is short and rounded off, resembling that of *Turnix*. The configuration of the pelvis closely resembles that of the Turnices. With regard to the nasal and premaxillary bones, *Pedionomus* and the Turnices are schizorhinal, in opposition to the holorhinal Rasores.

Resumé.

Some of the more noteworthy characters of the various organic systems of *Pedionomus* are arranged in the following tabular form in which the symbol * indicates agreement with the corresponding characters in the Turnices and in the Rasores, the symbol O shows that the characters are either peculiar to *Pedionomus* or that they agree with Ralline birds.

To settle the affinities of *Pedionomus* simply by the numerical majority of coincidences of these characters would be a not unprecedented but utterly fallacious mode of investigation. *The quality not the quantity of these "taxonomic characters" refers Pedionomus to the Turnices as their lowest most Rallo-Galline members.*

| Characters of Pedionomus. | Turnices. | Rasores. | Neither. |
|---------------------------------|-----------|----------|----------|
| Number of Primary remiges... | * | * | ... |
| Number of Secondary remiges | ... | * | ... |
| Absence of fifth secondary ... | ... | ... | O |
| Aftershaft structure ... | * | ... | ... |
| Number of rectrices ... | * | ... | ... |
| Pterylosis ... | * | ... | ... |
| Oilgland ... | * | * | ... |
| Nasal operculum ... | * | * | ... |
| Scutellation of Feet ... | * | ... | ... |
| Hallux ... | ... | * | ... |
| Second, third, fourth toes ... | * | ... | ... |
| Mus. caud-ilio-femoralis ... | ... | * | ... |
| Carotids... | ... | * | O |
| Syrinx ... | * | ... | ... |
| Absence of Crop ... | * | ... | ... |
| Liver, three lobes ... | * | * | ... |
| Liver, situation of right lobe | * | ... | ... |
| Intestinal convolutions ... | ... | ... | O |
| Number of cervical vertebræ | * | ... | ... |
| Brachial plexus ... | ... | ... | O |
| Number of sternal ribs ... | ... | ... | O |
| Spina communis sterni ... | * | ... | ... |
| Absence of Proc-obliquus sterni | * | ... | ... |
| Furcula ... | * | ... | ... |
| Pelvis ... | * | ... | ... |
| Nasal bones ... | * | ... | ... |
| | 18 | 8 | 5 |